Unit 18: Astronomy and Space Science

Delivery guidance

This subject will give your learners many fascinating facts and theories and an insight into human innovation and adaptability. They will need to plan observations and carry out research into the numerous associated industries, which includes materials and manufacturing, mechanical and electrical engineering, computers, communication, design, chemical research and engineering, education and practical research, aeronautics and aerospace.

Learners will need to develop their knowledge and understanding of the key areas in astronomy and space flight, and of the links between these exciting topics and related industries. They should look at the advances made in space flight and the varied subject disciplines associated with space science development, improving their investigative and research skills as they study.

You will introduce your learners to many new concepts and ideas, and they will need access to essential research materials, books, magazines, periodic journals, the internet and excursions to linked organisations. You can use a wide range of delivery methods for this unit, which could include:

- PowerPoint presentations – used to introduce the various topics and for your learners to present their work individually or in a group activity
- videos – a wealth of up-to-date presentations are available for you to enthuse your learners in current knowledge and theories and also as a means for research into historic space flight programmes
- case studies – many opportunities exist for a number of case studies to be highlighted in both space flight (past, present and future) and astronomy, present day developments and new discoveries
- discussion – you can use this as a means to determine understanding of the subject material by your learners and to inform your way forward in the topics covered
- practical demonstration and investigation – covering the essential requirements of safe working practices and knowledge of optical instruments, celestial coordinates, correct visual methods and recording techniques.

It is important for you to emphasise to your learners that the subject of astronomy and space science involves a high degree of independent research and personal study. Learners should have a general awareness of the subject material before beginning the course.

Approaching the unit

The learning aims in this unit should be delivered through a programme of tuition, facilitated learning, research and practical investigative work. You need to address health and safety issues for observations of solar activity and independent night-time activities.

Your learners will need access to:

- computer facilities, internet, relevant CD-ROMs, simulation models for essential research materials and aids to personal study of animation and actual video images

- portable telescopes (min. 50 mm refractive/100 mm reflective), binoculars (10 × 50 mm) and projection attachments to support naked eye observations and mapping
- optical physics equipment: lenses (converging and diverging), mirrors (concave spherical and parabolic if possible) and suitable light sources, for laboratory investigation of light, magnification and focus.

For **learning aim A**, you can introduce the topic by finding out what your learners already know about the solar system. Develop a discussion and then give a comprehensive overview of the most up-to-date knowledge of our solar system and the components within it. In groups your learners could then engage in research and produce detailed information about the internal structure of the Sun, Earth and Moon, which will serve to highlight the variation in terms of 'activity' which prevail in these objects and demonstrate the differences between stars, planets and moons. The Sun's effect on all objects in the solar system, and those objects which have extremely long orbital periods (e.g. comets), should be emphasised to illustrate the extent of the Sun's gravitational field and the limits of the solar system. The definition in this unit of 'other solar system' objects and features should be explained as referring mainly to everything apart from the Sun, Earth and Moon. The amount of information for these is now vast and you may wish to deliver just the essential aspects and simply allow learners to develop a PowerPoint of one feature from the list supplied, then collate them. It is important that your learners deal with data correctly, such as distances and diameters, and they should begin to compile a lot of information about the solar system and the methods we use to obtain this information. Learners could then produce a case study of a lander or orbiting spacecraft linked to a specific planetary or fact-finding mission.

For **learning aim B**, you should emphasise the importance for learners to fully appreciate the health and safety aspects of astronomical observations and all other practical activities that they will carry out. You should focus this on possible eye damage when viewing the Sun and full Moon, giving details to family members about your learners' locations and safe night-time observing.
A visit to a planetarium in a local university may help to introduce observations. You can demonstrate telescope construction with simple models and then concentrate on reflectors, refractors and associated ray diagrams. The physics for this section can be quite involved, but you should emphasise the aspect of practical investigation.

You should make use of a list of Earth-based radio and satellite telescopes and text or internet images when discussing observations using wavelengths other than the visible range. Actual astronomical observations and mapping are fundamental to the completion of this unit and to the development of important transferable skills. Show your learners the correct procedure for solar observations using the projection method and supervise them initially. You should also contact parents or guardians to ensure that out-of-hours observations by learners are conducted safely. Give your learners adequate guidance to ensure that they can identify regions of the sky quickly and to minimise the time spent on observations. Naked-eye observations are sufficient for most of the activities in this learning aim. Your learners must be able to record observational information and data accurately, so you will need to give introductory lessons on angles, celestial coordinates, phases of the moon, etc.

Learners will appreciate their observations much more if they can follow and 'capture' a sequence of sunspots across the face of the Sun over the course of a number of days, for example.

For **learning aim C**, you will introduce your learners to the practicalities of space flight, spacecraft design, useful spin-offs from space research and the future of space travel. In doing so, this section leaves aside the essential astronomical principles of the unit and concentrates on the fundamentals of space flight.

Your learners can begin to develop an understanding of the design aspects required for spacecraft and rockets achieve orbit if you pose the question: 'How can we get into space?' Encourage a group discussion so that you can determine the general knowledge and understanding of your learners. Further develop the group activities to produce a list of important points in the known design of rockets and spacecraft. Use current video footage of working on the International Space Station (ISS) as a means to link the practical work of space research to the difficult conditions faced in a near-zero-gravity environment.

Your learners would benefit from a focus into the planned development of a human mission to Mars in order to carry out research into the problems to be overcome weighed against the effort to achieve the goal. This can also lead you to develop a discussion concerning the morality of space flight when the Earth and its inhabitants are facing very difficult circumstances. The contextual nature of this topic should enhance the learning experience by illustrating that the progress made in space flight has had real impact in terms of biological, chemical and physical advances. You can then introduce the wider industrial context. You must ensure sufficient internet access to meet the demands of the research necessary to complete this learning aim, particularly in relation to materials development and commercial space ventures.

For **learning aim D**, your learners should demonstrate the principles of distance measurement and to report on the techniques used for deep space objects, following initial formal teaching of the principles involved. You will need to explain the various stages in the life of a star and show how these fundamentals help in our understanding of the development and demise of almost all known objects in the Universe. At this point, you may wish to link the life cycle of stars to that of our Sun, you can then introduce the Hertzsprung-Russell (H-R) diagram. Detail how the information in the diagram is related to observed stars, including the Sun.

You could arrange learners into groups and show them clips from different programmes that attempt to explain our theories of the origin of the Universe; they can then discuss all the relevant information to develop a summary. You could also discuss similarities and differences in the summaries further. You can give a number of accounts of the suggested fate of the Universe, asking for a spokesperson from each group to put their point across. Your learners can then make an informed decision as to what they collectively believe will be the eventual outcome and why. This learning aim is likely to be delivered best by a combination of formal lecture, practical task, computer-aided modelling, group discussion, independent research and visits to related educational lectures.

The subject material for this unit is both interesting and challenging, in terms of the concepts, terminology and application of science. Further tuition may be necessary to ensure that the celestial coordinates and star identification are accurately portrayed and that sufficient time is awarded to convey the significance of the Cosmic Microwave background for supporting the theory of the Big Bang.

Assessment Model

Learning aim	Key content areas	Recommended assessment approach
A Understand the fundamental aspects of the Solar System	**A1** Features and characteristics of the Sun **A2** Features, characteristics and relationship factors of the Earth and Moon **A3** Features and characteristics of the inner and outer planets **A4** Features and characteristics of other Solar System objects	A scientific report and diagrams. Use of terms and numerical values. Presentation document. Outline of features/ numerical values associated with Earth and Moon. Diagrams and text information for all planets. Descriptions of smaller components. Case studies of spacecraft encounters.
B Undertake measurement and observation of astronomical objects	**B1** Earth-based telescope design and features **B2** Space-based telescope design, features and observatories **B3** Night sky-mapping and observations **B4** Daytime observation	Descriptions of important telescopes, optical and radio. Geographical positions. A report on specific telescopes using range of wavelengths. Investigating focal points of concave mirror and convex lens. Practical observation logs. Map of night sky and terminology definitions. Practical observation by projection of sunspot activity.
C Investigate the essential factors involved in space flight	**C1** Spacecraft design **C2** Practicalities and physics of spaceflight **C3** Future of spaceflight and exploration **C4** Factors and benefits associated with Earth-based applications of space technology	Report on spacecraft materials using specified named vehicles. Conditions for space flight. Maths associated with speed, gravitational forces, re- entry conditions. Case study: PowerPoint presentation on spacecraft designs, Moon missions, Mars probes, space stations, international plans. Space spin-offs: examples of research activities performed by astronauts.

Learning aim	Key content areas	Recommended assessment approach
D Understand the fundamental concepts outlined in astrophysics and cosmology	**D1** Principles of star creation **D2** Principles of the 'death' of stars **D3** Observable characteristics and properties of stars **D4** Origin and theories of evolution of the Universe and astronomical dimensions	Information poster outlining the life cycle of stars. Report of star characteristics linked to star formation and death. Detailed Hertzsprung-Russell (H-R) diagram aspects. Trigonometric parallax principles outline. Presentation: origin and end of Universe – current theories and evidence explained.

Assessment guidance

This unit is internally assessed by a number of internally set assignments. Each assignment should cover at least one complete learning aim. It is essential that a learning aim is assessed as a whole and not split into tasks or sub-tasks per criterion. There are four suggested assignments for this unit, which cover the learning aims individually.

All learners must independently generate individual evidence that can be authenticated. The main forms of evidence are likely to be written reports and diagrams. There will also be practical observational work including logbooks, sketches and possibly photographic evidence. Learners should incorporate in-depth research that is corroborated by a fully referenced bibliography.

It is not a requirement for learners to deliver their presentations, but it can be motivating to do so and this can also provide supplementary evidence in the form of observation records (completed by the assessor) and witness statements (from other experts). Presentations could be made to the learner's peers, or if they are in placements or part-time work to colleagues and other departmental staff and laboratory technicians. However, observation records and witness statements are not sufficient sources of evidence alone: it is important that the full presentation is submitted. Assessors should remember that they are assessing the content of the presentation against the learning aim, and not the skill with which the presentation was delivered.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 18: Astronomy and Space Science

Introduction

Begin by introducing the unit to learners through a group discussion exploring the level and breadth of their subject knowledge to date. Outline, in clear terms, the learning aims of the unit, the content involved and the expectations for learners in terms of independence and group activities.

Learning aim A – Understand the fundamental aspects of the solar system

- Give an introduction to the Earth-Moon system using an appropriate video clip. Insist on notes taken by learners. It may be useful to outline, very briefly, how our current knowledge has developed from mistakes and observations in history. Ask learners to produce a report and diagrams on the Earth-Moon system showing a cross-section of each body and describing surface features, orbits, eclipses and other characteristics.
- Demonstrate the close links between the Sun, Earth and Moon by using appropriate models and video images, outlining the forces involved and their effects on each other. Learners could then produce a PowerPoint presentation that shows the effects of these objects on each other and the cycles of orbits, eclipses and other effects experienced from Earth.
- Explain the processes of nuclear fusion by formal tuition. Include the chemical composition of the Sun and the internal structure. You should outline nuclear fusion in terms of the 'fusing' of protons and the conditions required. Describe the Sun's atmosphere and spectral lines, referring to the principles of emission and absorption and chemical elements. Ask learners to produce a full diagram of the Sun in cross- section, highlighting the internal processes taking place. The Sun's internal processes should be shown clearly and coherently with an accurate explanation of the importance of emission and absorption spectra.
- Our knowledge and understanding of the objects in the solar system changes regularly. The wealth of information makes it difficult to cover the topic in a short presentation, so you should aim to give a very brief overview of key aspects to date. Open the topic to learners, asking them to give full details of the solar system using a variety of presentations including posters, PowerPoint and modelling. All other planets, relevant minor planets, important moons, comets, meteors and outer bodies are to be included. This could be completed in groups and the individual subjects – for example, Jupiter and its moons, Saturn's moons and ring system – may be separated out to compile a whole-class piece of work.
- Give key points on Kepler's laws of planetary motion. Include the ellipse, which you can ask learners to demonstrate themselves using two tacks, a sheet of paper, string and a pencil, the changing velocity of planets using equal area triangles, and the principle that T^2/R^3 ratio is the same for all planetary motions and also for all man-made or natural satellites. This latter law can be shown by asking learners to calculate T^2 and R^3 from known data. Conversions will be expected from years into seconds and from kilometres into metres.
- Introduce some basic information about previous and more recent space probe missions to highlight where our current knowledge has come from. Learners can then choose from a suggested list to produce a case study, for example, Voyager 1 and 2, Mars Lander, Giotto, Rosetta/Philae to comet 67P. Learners will develop and refine their research techniques in this

activity and learners can voice their findings in group discussion.

- Arrange a visit to a science museum which has a collection of meteorites. Following the visit, ask learners to report on meteor showers, asteroids and both Kuiper Belt and Oort Cloud. This work should be linked to their visit to the museum.

Learning aim B – Undertake measurement and observation of astronomical objects

- You should introduce the topic by using a series of photographs or a PowerPoint display, which shows the wide variety of land-based and space-based telescopes which are currently used. Through formal tuition, introduce the basic principles of reflector and refractor optical types with diagrams that learners should draw accurately. You will then need to outline the main principles of telescopes that do not detect visible light by explaining the differences in wavelength and the images which can be produced. Learners will then identify the different types of telescopes in current use using a report style document and appropriate diagrams. The report will be based on both ground-based and space-based telescope designs. Examples of each type are to be fully described and the mode of operation outlined: reflectors, refractors, radio telescopes, microwave, infrared, ultraviolet, X-rays and gamma rays.
- To enhance learners' understanding, demonstrate the basic method and then ask learners to give a practical determination of focal points for converging and diverging lenses and concave mirror using a twin-hole ray box. If possible, in terms of equipment and time, you could task learners to build a simple Newtonian reflector.
- Practical observational astronomy should be introduced with a visit to a planetarium or similar establishment. You can then make references to the night sky using maps and slide images. You will need to give the mapping of the night sky careful thought and special attention, since many learners will be new to the subject. Suitable maps are to be made available and the coordinates explained carefully, ensuring, by a simple test, that all learners are able to plot the position of an object. The use of iPads to show the current position of constellations may work to good effect at this point. Learners should then be given an opportunity, by night-time observation, to identify a significant number of constellations, various planets and prominent stars, plotting them on their maps and providing coordinates which can then be compared in the next tutorial session. Jupiter, Saturn, Mars, Venus, Mercury, the Moon, Vega, Deneb, Altair, Rigel, Betelgeux, the Pole star, etc. are useful starter objects for this purpose. Constellations will need to be identified by learners using their common and correct names. You will need to comment on the safety aspects of night-time observations and remind learners about the completion of accurate logbook recordings of data over a suitable timescale.
- Ask learners if they have any knowledge of constellations or objects that may only be visible in the southern hemisphere. Give learners a list of a few constellations and stars in response. Attempt to project the celestial equator from a globe of the Earth and illustrate why southern observers see a different night sky. Ask your learners to produce a map similar to that of the northern hemisphere.
- Give a firm, clear warning to learners when introducing practical observations of the Sun, explaining the danger of looking directly at the Sun, with or without optical aids, or looking for too long at projected images. Once the basic method of projection has been demonstrated in the laboratory or in video, and learners have practised the method themselves, they should make suitable recordings of sunspot activity over a period of seven days across the face of the Sun. They should use circular templates and accurately record the size of sunspots as drawings. They can then calculate the Sun's possible rotational period. If conditions allow, a transit of Mercury would present a further or alternative opportunity.

- Instruct learners to produce further explanation in a report from their sunspot observational logs. They should be able to estimate the size of sunspots from the known diameter of the Sun based on their observational drawings. There should be some attempt to produce good definition in their sunspot drawings.
- Introduce this next phase of observations with a safety warning about night-time viewing and suitable lighting techniques. Learners must ensure that someone knows where they are when carrying out their observations. You must ask that your learners produce an explanation, in a report, of the passage of a planet(s) or other suitable observable astronomical body in the night sky over a suitable period of time. Their log must include detailed maps showing motion against background stars, coordinates of motion and other relevant labels, such as constellations, stars (with known types/classes indicated), other planets in the field, known galaxies if observable, etc. If learners have access to telescopes or powerful binoculars, they could give observational records of the motion of the four Galilean moons around Jupiter or phases of Venus. Learners could carry out observations of other events, such as eclipses, transits and comets if the phenomena are available. Observations of meteor showers are of limited value, but are interesting. Learners can use photographic evidence for most observations listed.

Learning aim C – Investigate the essential factors involved in space flight

- Show a suitable video clip of a launch of the Apollo Saturn V rocket or Space Shuttle. With audio, these launches are very impressive and give a good starting point for discussion. You may wish to show the launch of Space Shuttle 'Challenger', to enhance the discussion by introducing the real risks of space flight. Ask your learners to research and report, with the aid of a poster, on the general principles of space flight, the forces involved in propulsion of a rocket and general data for fuel, length of 'burn' and mass at lift off. Examples can be taken from known values for Saturn V or the Space Shuttle. You should include the need for 'gimbals' in stability and stages in propulsion, and perhaps ask learners to demonstrate this by attempting to balance a ruler upright on their hands.
- You should use suitable video footage of actual space missions and astronauts in space. This may include early space flight or the ISS. Point out the main aspects that need to be considered at the various stages of the video, then ask learners to present a group report detailing the factors which need to be considered for space flight to be achieved. This will include: data of fuel and stages of sustained lift when overcoming gravitational forces, velocity required for low orbit (escape velocity calculation from Earth and the Moon, for example) and gravitational assist for distance flights; costs involved; implications for human travel – space suit design, micro-gravity environment, radiation zones and psychological aspects of sustained missions.
- Give information on the use of gravity assist for longer distance space flight and introduce the activity as a case study. Your learners can produce a scientific report for a magazine based on an overview of the flights of Voyagers 1 and 2 to the outer planets using a rare planetary alignment and gravitational 'sling-shot'.
- Ask learners to discuss what the present uses of satellites are. Let them know that satellites have a variety of orbital 'heights'. Link the discussion to communication and geo-stationary orbits at a distance of 36 000 km, low-earth orbits for Earth research and the ISS. Pose the question: 'What happens to all this machinery when it is no longer needed?' You can illustrate this with the eventual return to Earth and burn-up of Sky-Lab over Western Australia in 1979. Problems associated with the build-up of space debris and the future of space flight can form the basis of a research report entitled 'Plans for clearing unwanted and dangerous pieces of spacecraft'.

- Introduce this topic by asking learners to research and produce a series of posters or information leaflets which outline:
  - the benefits of continued space exploration – tabulated document identifying and explaining the knowledge and applications learned from planetary and space exploration
  - the benefits of space research – tabulated document outlining at least three developments used in everyday life from all the categories listed in the contents section.
- Open a discussion based on 'The future of space flight'. Your learners should produce a variety of views on this topic. You can present a table of items known to have been developed from space technology or developments in the need for new technology in space. Ask your learners to present a well-worded journalistic report- style document which outlines:
  - the main accomplishments of space exploration to date and the impact to society in terms of benefits and costs (human, environmental and financial);
  - a detailed overview of the proposed space missions from all nations involved, manned and un-manned;
  - an appraisal of the difficulties needed to be overcome;
  - the reasons for the missions; and
  - a coherent personal viewpoint on the benefits of the programmes to science, research and human development.

Learning aim D - Understand the fundamental concepts outlined in astrophysics and cosmology

- Outline the key aspects of the Hertzsprung-Russell (H-R) diagram by formal tuition. The importance of the diagram to graphically illustrate the life cycle and characteristics of known stars should be the focus. Ask learners to produce a clear and detailed poster showing this diagram and set a number of questions on the spectral class and luminosity. Give further tuition on the current knowledge relating to the life cycle of stars with masses equal to or smaller than our Sun and those with masses greater than our Sun. Learners must then include this cycle as a diagram on the poster, which they can then compare between groups. It is important to encourage questioning based on the exact sizes and masses of stars and their proposed life cycles. You will need to explain fully the positions of prominent and well-known stars on the H-R diagram and the interpretation of the diagram itself.
- Introduce the methods used to determine distances to stars and galaxies for practical work. Your learners will be investigating the trigonometric parallax method of distance measurement by mathematical means, which can be carried out on a suitable table in a laboratory using trigonometry. There are many worksheets available for this method. Learners should become familiar with the method used and how it relates to the different positions in the Earth's orbit to distant astronomical objects. The work will be evidenced by diagrams and calculations
- Outline in general terms how Cepheid variable stars or 'standard candles' are used for greater distance measurement. Include also the use of some supernovae explosions such as in the Pinwheel galaxy, which happened in 2011. This event has been well photographed. Mention that a collective approach to distance measurement is called the 'Distance ladder', and that the uncertainties are reduced but increase with distance of the object.
- Ask learners about their understanding of the origin of the Universe to determine the extent of knowledge. Give a timeline and sequence of events from current theory and dispel any

misunderstandings which may have been identified in the Q&A session. With the help of video clips, give information for both Steady State and Big Bang theories, emphasising that the latter theory appears to be the preferred model with some slight variations. Make sure to include 'Olber's Paradox', which links the brightness of the Universe to its age. You should then introduce a diagram that outlines the known composition of the Universe. Learners can produce independent reports on descriptions of main theories, discussion on differences and similarities, and an overview of the evidence in support of the main theory with a focus on red-shift and cosmic microwave background.

- Following on from the previous topic, discuss the possible fate of the Universe identifying aspects of the critical density. Present an opportunity for learners to research and summarise this topic as a case study – 'The Fate of the Universe'. Learners should detail the possible outcomes based on density and present a discussion of alternative ideas. You could use a projected time-line from 13.7 billion years ago (the Big Bang) to 9.1 billion years ago (formation of the solar system) to present day to 10 billion years in the future (our Sun becomes a white dwarf) to 10^{150} years in the future (Photon age – Universe reaches low energy state). Assessment could be supported through observation records.
- This entire topic can be finalised with a useful class discussion on the possibilities and the probabilities of 'life' elsewhere in the Universe. You will need to give a definition of life in terms of a life cycle based on carbon. You should also mention how many exo-planets have been discovered and that water, already known to exist frozen on Mars, is a vital ingredient. The principle of discovery of exo-planets can be illustrated using an object moving across a torch beam to show a decrease in light emission. You can encourage learners to present their own views on whether life could exist elsewhere, in the form of a clearly worded essay or newspaper article.

Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit links to:

- *Unit 1: Principles and Applications of Biology I*
- *Unit 2: Principles and Applications of Chemistry I*
- *Unit 4: Investigative Project Skills*

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC International qualification in Applied Science. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Couper, H *Universe: Stunning Satellite Imagery from Outer Space*, Cassell, 2007 (ISBN: 9781844034376).
This book contains full-colour photographs and descriptions of the solar system and deep space objects from Hubble Space Telescope and other satellites.

Hope, T, *Spacecam: Photographing the Final Frontier*, David & Charles, 2005 (ISBN: 9780715321645).
This book contains photographs and information in co-operation with NASA on space flight, the Universe and Earth's geography.

Kerrod, R and Scott, C *Hubble: The Mirror on the Universe*, David & Charles, 2008 (ISBN: 9780715329238).
This book contains an impressive and inspirational set of photographs of deep space objects from the Hubble Space Telescope.

May, B, Moore, P and Lintott, C *Bang! The Complete History of the Universe*, Carlton Books Ltd, 2007 (ISBN: 9781844422319).
This gives an up-to-date account of our knowledge on the possible creation and the possible end of the Universe with useful photographs, images and timelines.

Moore, P *Philip's Astronomy Encyclopedia*, Philip's, 2002 (ISBN: 9780540078639).
This book contains an A–Z dictionary of terms with coloured images, detailed explanations and star maps.

Journals

British Astronomical Association
This is a bimonthly journal containing relevant observational guides, forthcoming astronomical events, etc.

The Sky at Night (also www.skyatnightmagazine.com)
This is a monthly publication providing useful observational practices and forthcoming events in the night sky.

Videos

www.youtube.com
On YouTube you can find the successful Apollo 8 Saturn V launch, the final launch of Endeavour illustrating the difference in launch of the shuttle to Saturn V, plus the dangers of space flight in the Shuttle Challenger disaster. You can also find ultra-high-definition video from the International Space Station here.

https://www.youtube.com/watch?v=CiLNxZbpP20
Video IP1 12 Comet Shoemaker-Levy collides with Jupiter
This video relates to the collision of a comet with an outer planet, outlining our dependence on large planets to protect us from large collisions and also giving evidence of historical collisions.

The Wonders of… collection (*The Wonders of the Solar System*, *The Wonders of the Universe*, *The Wonders of Life*) is presented by Professor Brian Cox and available on BBC DVD (2014). These programmes give clear and up-to-date information about important aspects in this unit.

https://www.youtube.com/watch?v=SGP6Y0Pnhe4
This is one example of videos about working on the International Space Station (ISS).

Websites

http://www.wired.co.uk/news/archive/2015-07/28/nasa-4k-views-of-earth-iss
NASA footage shot on board the ISS showing astronauts experimenting, and views of Earth from space.

www.esa.int
The official website of the European Space Agency.

www.jpl.nasa.gov
Jet Propulsion Laboratory, California Institute of Technology.

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.